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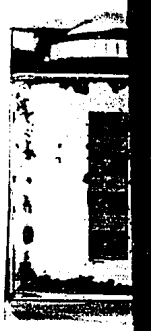

PROBLEMS OF INFECTION AND IMMUNITY IN RADIOBIOLOGY

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The Geneva scientific and technical conference on the peaceful utilization of atomic energy pointed out what a large quantity of diverse problems in numerous fields of science, technology, and medicine are embraced by the problem of the peaceful utilization of atomic energy. In the medical reports which were presented at the plenary sessions of the conference, two great tasks of modern medicine were clearly revealed: first, the utilization of atomic energy for the diagnosis, prevention, and medical treatment of illness and, second, the protection of humanity from the destructive effects of nuclear radiation. The huge significance of these tasks is emphasized by the closing words of the report of the International Organization on Public Health Problems:

"Our generation is obliged to transmit as a legacy to our descendants not only nuclear technology with all of its useful applications, but also the corresponding knowledge concerning the struggle with the dangers characteristic of it."

All fields of medicine are at the present time in one way or another interconnected with the problem of atomic energy. Such branches as, for example, microbiology, immunology, and epidemiology have extensive, many-sided contacts with it. In each of these fields there are two aspects: the study of the effects of ionizing radiation on causative factors of infectious diseases as well as infection and immunity, and the application of the method of tracer atoms for scientific investigation.

Not long ago the problem of the effect of large doses of radiation on microorganisms was only of theoretical interest, for the power of the sources of radioactive radiation was greatly limited. The sensitivity of microorganisms to these radiations was low. Suffice it to say that a bactericidal dose X rays lies in the range of hundreds of thousands or millions of roentgens, whereas the average lethal dose for laboratory animals is less than 1,000 roentgens.

At the present time there is, in fact, no limit to the strength of the doses of radiation which can be utilized to exert an effect on microorganisms. Therefore the question of "cold sterilization" by means of ionizing radiation has become actual. A report by Proctor and Gouldblit (US) was given at the Geneva conference from which it is seen that certain methods of utilizing radiation for the preservation of food products have already been developed. Soviet investigators are also working in this direction.

There are also other methods of utilizing ionizing radiation as a means of sterilization. At the conference a report of Brownell (US), concerning the application of penetrating radiation for the sterilization of bandage materials -- cotton, gauze, ligatures, etc, -- was presented. It was determined that for the sterilization of packages containing bandage materials, radiation in doses of 4 million roentgens is necessary. The author of the report presented in detail a formulated set of conditions for the sterlization of bandage materials by means of gamma rays. According to this plan,

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fuel (uranium) bars, which industrial enterprises operating reactors will lease, are the source of radiation. Bandage materials are piled on a tray and irradiated by the fuel elements, which are arranged along a conveyer on which the materials are moved. The account showed that this method of sterilization is considerably cheaper than the disinfection commonly used in autoclaves.

Still more interesting are the prospects which are being opened as far as the production of bacterial preparations and the sterilization of donors' blood are concerned. Work is now being conducted on these problems.

Atomic energy provided medical microbiology with a new method of scientific research -- the method of tracer atoms. In general microbiology this method has already found wide application in the study of the metabolism of bacteria. In medical microbiology it is still inadequately used, although a number of experiments, especially in the field of research on bacteriophages, have already been carried out by the method of radioactive isotope tracers.

The method of tracer atoms is applied also in the field of chemotherapy. By tagging antibiotics and sulfonamide drugs with radicactive tracers, research workers are enabled to trace their circulation in the organism, their combination with bacterial cells, and their elimination from the organism. A paper dealing with one of the experiments in the field of chemotherapy was presented at the Geneva conference. It gave an account of the absorption by various tissues of the organism, especially nervous tissue, of 4: 4' diaminodiphenyl-sulfone, a new drug which has a pronounced activity in the therapy of leprosy. The report was presented by the Indian investigators Saraya, Khanolkar, and Gopal-Ayengar.

The question of the effect of ionizing radiation on infection and immunity has great theoretical and practical significance. From the very beginning of the present century, the effect of X rays on the immunobiological resistance of the organism has formed a subject of research. In connection with the rapid progress of nuclear physics and with the development of the atomic energy industry, interest in this problem has increased sharply. During the past decade a large amount of research on the subject of effects produced by ionizing radiations on infection and immunity was conducted by Soviet and foreign scientists. In connection with this, a report was given concerning the effects of both internal radiation and external radiation which originate upon the introduction of radioactive substances into the organism.

Investigation shows that large doses of ionizing radiations lower the resistance of the organism to infection. As a result of the suppression of natural protective mechanisms and the disturbance, under the effect of exposure, of the permeability of intestinal walls, bacteria can penetrate from the intestine into the blood, and thus cause bacteriemia. The autoinfection process which originates in the most intense stage of radiation sickness expedites the course of this sickness and increases the rate of lethality therefrom. The favorable effect of chemotherapy in the medical treatment of radiation sickness, as was demonstrated in experiments on animals, showed how great the significance of autoinfection is in determining the course and outcome of radiation sickness. Naturally, therefore, the study of the mechanism of the autoinfection process in radiation sickness and also of the development of methods of chemotherapy of this type of infection become very important. Soviet investigators have shown that as a result of the reduction of natural resistance and also of specific immunity there is transformation, under the influence of acute radiation effects, of clinically unobservable, latent forms of certain diseases (for example dysentery) into clinically evident forms.

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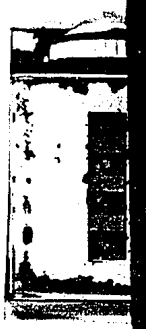

The effect of ionizing radiations on artificial immunity has a major significance. X-ray exposure due to administration of a sufficiently large dose of radiation not long before the introduction of an antigen into the organism reduces or even completely arrests the formation of antibodies. Exposure to radiation after a certain time has elapsed since the end of immunization does not exert marked effects on the condition of antibodies and the dynamics of their formation. According to the data of Soviet and foreign authors, it is possible to discern the occurrence of two phases in the process of the formation of antibodies: the first is the brief radiosensitive phase and the second is the radioresistant phase, which comprises all of the rather prolonged period of formation of antibodies [that follows the first phase]. It is interesting to compare the effects of exposure to radiation in different phases of antibody formation with the afflictions of various organs and systems of tissue in the organism at different periods of radiation sickness. Investigations along this line may reveal much about the physiological aspects of antibody formation.

The study of the effect of exposure on immunogenesis is extremely important not only from the standpoint of the formation of antibodies, but also from the point of view of increases in the general resistance of the organism to infection, which does not always run parallel to the formation of antibodies. In this field much has already been done by Soviet investigators. In addition to its theoretical significance as far as clarification of the nature and mechanism of immunity is concerned, research of this type also has great practical significance. How intense or prolonged exposure affects acquired immunity to different infections, and whether active immunity to different stages of acute radiation sickness and particularly chronic radiation sickness is possible, are problems that must be studied. It is also necessary to give clear recommendations concerning the advisability of giving preventive vaccinations against various infections to persons who are subjected by the conditions of their work to constant exposure to radiation even if the doses to which they are exposed are within safe limits.

At the Geneva conference, a report by I. A. Pigalev was presented, in which some research of Soviet scientists concerning the problem of the effects of ionizing radiation on immunity was revealed, and some facts not described in the foreign literature were brought out.

In immunology, as in microbiology, the method of tracer atoms is of great importance. In a review report given by Dickson (US). The methods by which research is conducted with the application of the method of tracer atoms were described.

A number of investigations was devoted to the study of the fate of tracer antigens in the organism. Abroad, they studied chiefly bovine serum globulin tagged with radioactive iodine.

Soviet investigators studied the fate of bacterial antigens (whole antigens of bacteria of the intestinal group) by means of the method of tracer atoms. This problem has not yet been investigated completely. Nevertheless, resolution of that problem might permit us to give an objective appraisal of the different methods of introduction into the organism of vaccines against intestinal infections.

The application of the method of tracer atoms in the study of the formation of antibodies, their combination with antigens in the organism, and their destruction presents particular interest. By introducing aminoacids which are tagged with radioactive sulfur into the organism it has been successfully shown that antibodies are synthesized from amino acids contained in the organism.

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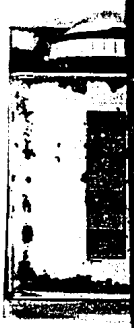

The application of radioactive isotopes in immunology can also serve an entirely different purpose. Already beginning with 1948, attempts have been made (Pressman, etal., in the US) to introduce a tumor tissue antibody tagged with radioactive iodine into the organism. This method has not yet yielded satisfactory results. Beil and Spear (US) reported on attempts to solve the problems in question by other methods. The authors proceeded from the recently discovered fact that animals which have been immunized against organs of another species can form antibodies which will react with their own tissues. These investigators obtained such antibodies, or antibody-like substances, which were active against rabbit kidneys. These antibodies were iodized by means of radioactive iodine. It was shown that upon the introduction of such a preparation into a rabbit, the iodine displayed a clear affinity to the kidneys, where it was localized to a considerable degree. By such a method, radioactive iodine was successfully transported to a definite organ. Of course, these attempts are still very far from the development of a method for the medical treatment of malignant tumors, but they are highly interesting as far as the search for new methods is concerned.

There are still no data concerning the effect of ionizing radiation on the course of epidemic processes. This problem is connected with the study of the general problem of the action on human beings of small doses of radiation emitted by radioactive substances. At the present time investigators are employing atomic energy in epidemiology by applying the method of tracer atoms to the study of different problems. The utilization of radioactive isotopes permits the study of the role played in epidemiology by arthropods, which are transmitters of human and animal diseases. By tagging with isotopes mosquitoes, flies, gnats etc., it is possible to study the distance of their flight, length of life, and connection with hosts (human or animal). This method permits the marking and identification of a large number of transmitters with a minimum expenditure of labor and material. By means of the introduction of radioisotopes into animal husbandry, the study of the parasitic connection between the arthropods and the vertebrate animals has been made possible.

Other methods have also been developed: the tagging of bacteria with radioisotopes and the study of their dissemination in the form of aerosols in connection with droplet-infection by way of the air, the tagging of insecticides and the determination of their dispersion (for example, when sprayed from airplanes), etc.

All the foregoing clearly shows how wide the new field of scientific investigation is.

Some people think that problems of radiation and radiobiology bear no relationship to the activity of institutes of epidemiology and microbiology. Only people who look backwards and cannot see either the future or present can think thus. The problems of radiation should be investigated not only at individual laboratories of some institutes; they should be subjected to study and applied in the most varied subdivisions of microbiology, immunology, and epidemiology.

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